

Climate Change – The Globe Down to the Southwest

Jonathan Overpeck, The University of Arizona



Outline of talk:

- (1) Climate in the news - 2011
- (2) Global climate change
- (3) Implications for Arizona and the Southwest



Source: Phil Pasteris, Global Water Resources, April 16, 2009

Climate in the news 2011... Drought and Wildfire

La Nina, blamed for U.S. South drought, may revive this autumn



2011 AZ and NM wildfires largest ever for each state

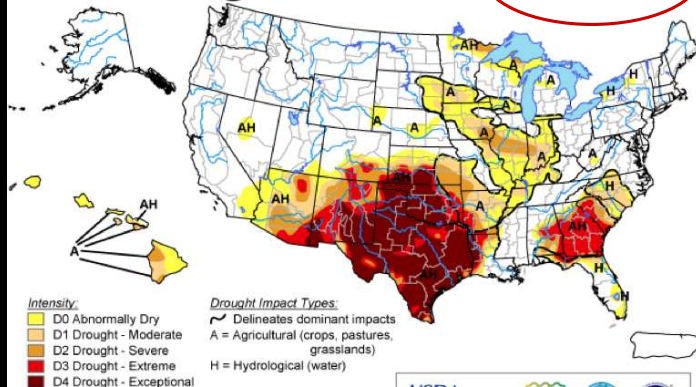
1400 homes destroyed this month in Texas



Texas-Fire and NASA

U.S. Drought Monitor

September 20, 2011
Valid 6 a.m. EDT



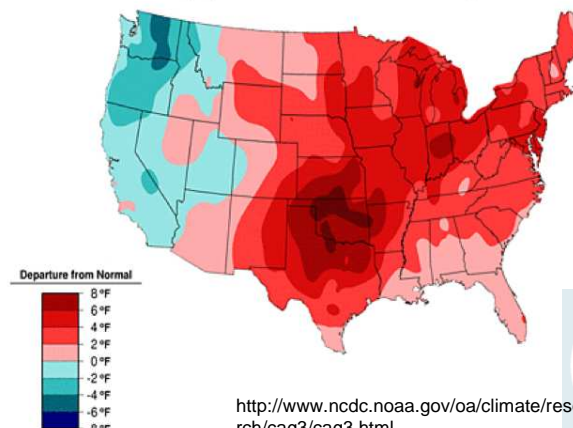
The Drought Monitor focuses on broad-scale conditions. Local conditions may vary. See accompanying text summary for forecast statements.

<http://drought.unl.edu/dm>

Released Thursday, September 22, 2011
Author: Michael Brewer/Liz Love-Brotak, NOAA/NESDIS/NCDC

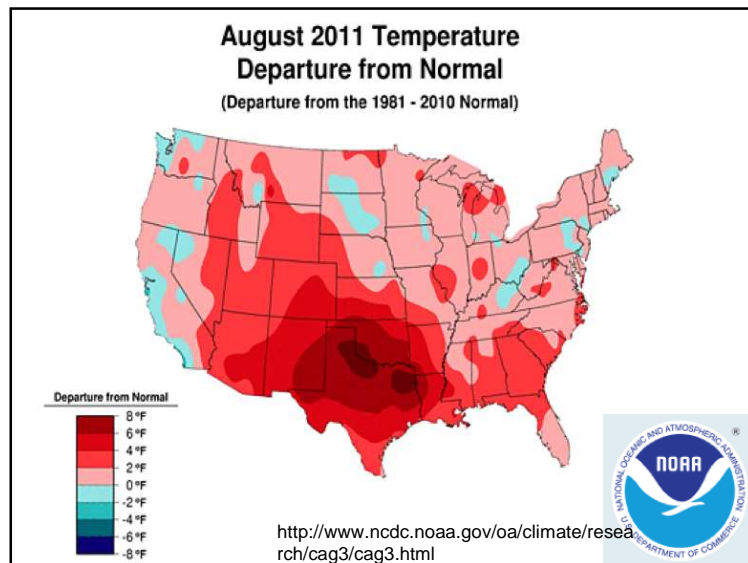
July 2011 Temperature Departure from Normal

(Departure from the 1971 - 2000 Normal)



<http://www.ncdc.noaa.gov/oa/climate/research/cag3/cag3.html>





Climate in the news 2011... *Unusually deadly tornadoes*

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What's Behind 2011's Deadly Tornado Season?

by ADAM COLE

Charlie Nease/AP

Cobbie Surin salvages items from her parent's home in Joplin, Mo. The tornado that struck Joplin on Sunday killed at least 125 people.

<http://drpinna.com>

The Joplin tornado is the deadliest single tornado since modern recordkeeping began in 1950 and is ranked as the 7th deadliest in U.S. history

Climate in the news 2011... *Major Flooding...*

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Flood recovery will require patience

Hurricane Irene: Flood Watch Issued

Wednesday, August 31, 2011 5:31 pm

The Missouri River spent two months in flood stage, but local officials should prepare to spend years in flood recovery.

paner li

ni.com

Climate in the news 2011... *Hurricanes delivering more moisture*

Hurricane Irene targets Fla., Carolinas

By Dan Vergano, USA TODAY Updated 28m ago

Comment 28 Recommend 143 Tweet 30

Picking up steam, Irene, the first hurricane of 2011, looks headed for major storm status and for Florida and the Carolinas.

Tropical Storm Force Wind Speed Probabilities
For the 120 hours (5 days) from 2 AM EDT Sun Aug 28 to 2 AM EDT Sun Aug 29

Probability of tropical storm force surface winds (15 mph or greater) from all tropical cyclones

Probability of hurricane force surface winds (39 mph or greater) from all tropical cyclones

Indicates HURRICANE IRENE center location at 2 AM EDT Tue Aug 29 2011 (Forecast Advisory #4)

<http://photos.denverpost.com/mediacenter/2011/08/irene-the-first-atlantic-hurricane-of-2011>

Climate in the news 2011...
Heat Waves...

guardian.co.uk
News | Sport | Comment | Culture | Business | Money | Life & style
News > World news > United States

Heatwave sweeps US claiming 22 lives
National weather service warns people to stay indoors and electricity companies warn of power outages

PINAL COUNTY
Pinal utility cuts off customers amid August heat wave
Heatwave breaks records in parts of US and Canada

by Lindsey Collom - Sept. 2, 2011 10:00 AM
The Arizona Republic

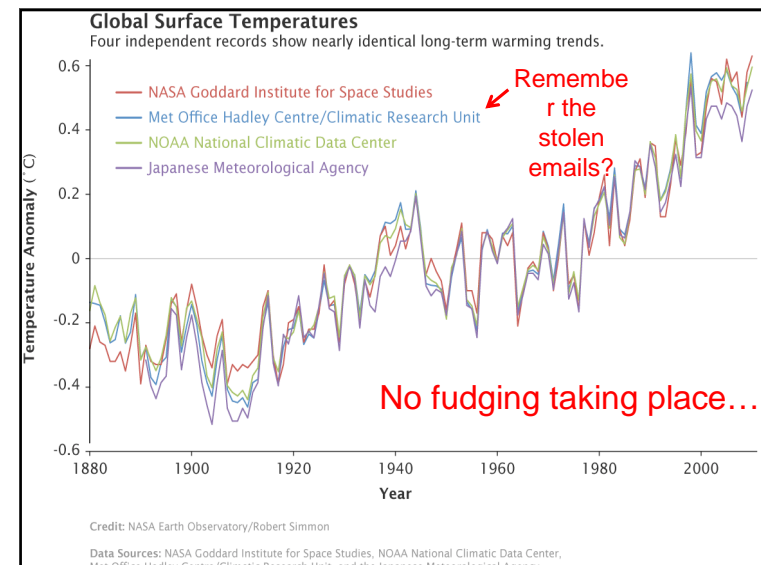
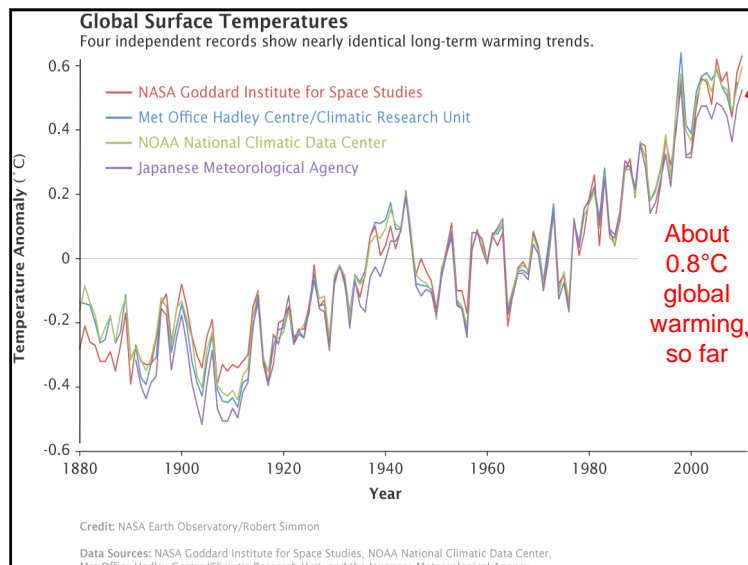
Record number of days above 110°F in Phoenix

108°F in New Jersey!!



What's going on?

Global Warming?
Climate Change?
Natural Variability?



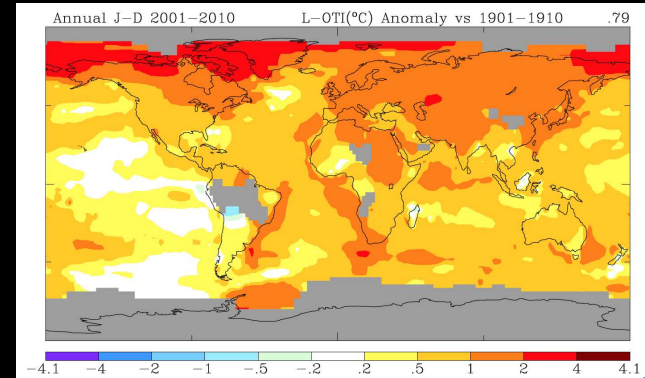
The climate challenge includes...

...both climate variability and climate change

...both natural and human-caused change
(warming trend is ca. 90% human, 10% natural)

...change that is already clearly underway

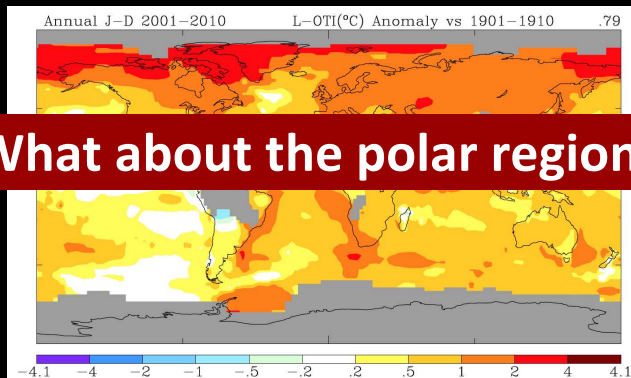
The Earth has warmed almost everywhere - very likely (90% sure) mostly due to humans



Temperature change between decade 1901-1910 and decade 2001-2010 (°C)



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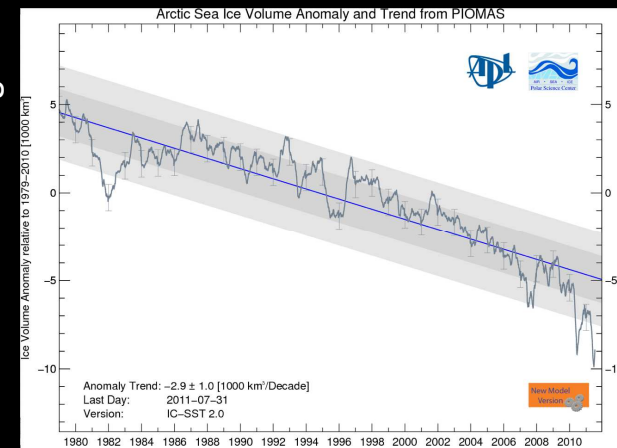


What about the polar regions?

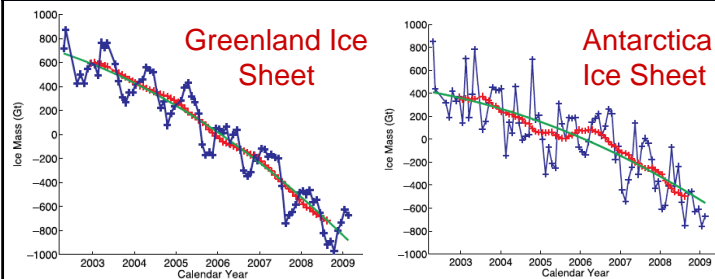
Temperature change between decade 1901-1910 and decade 2001-2010 (°C)



The Volume (Area x Thickness) of Sea Ice in the Arctic has been plummeting



Accelerating Ice Sheet Mass Loss



- Graphs show *relative* changes in ice mass
- Ice mass is decreasing in both hemispheres
 - 1500 Gt from Greenland, 800 from Antarctica = 2300 Gt ice
 - About 7 mm of global sea level rise in 7 years (ca. 30% of total)
- Rate of mass loss has doubled: melt is *accelerating*
- Data from GRACE satellite project (gravity data) - Velicogna 2009, GRL

Turning to climate change...

IPCC, 2007

“Global Warming is *unequivocal*”

Since 1970, rise in:

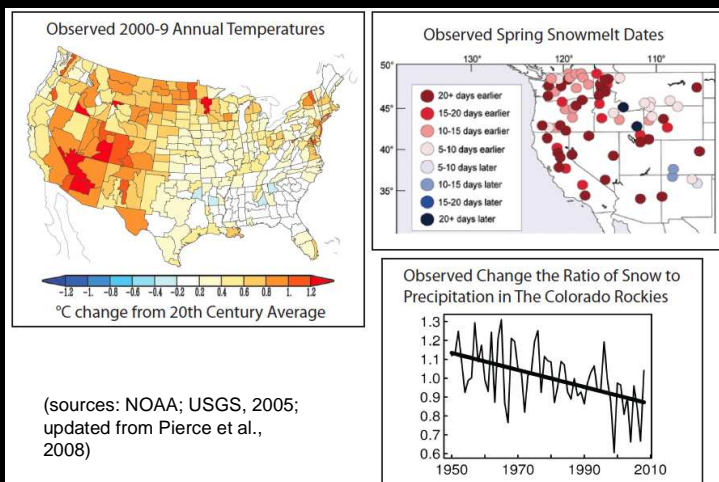
- Global surface temperatures
- **Extreme high temperatures**
- **Heat waves**
- Lower atmosphere temperatures
- Global sea-surface temperatures
- Ocean heat content
- Water vapor
- **Rainfall intensity**
- **Drought**
- **Hurricane intensity**
- **Global sea level/coastal flooding**

Decrease in:

- NH Snow extent
- Arctic sea ice
- Glaciers
- Cold temperatures



Evidence of climate change in West clear...



(sources: NOAA; USGS, 2005;
updated from Pierce et al.,
2008)

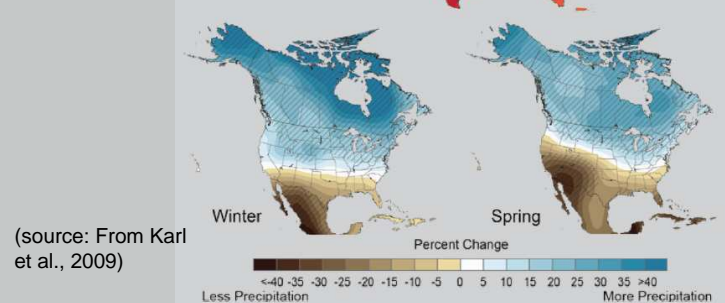
U.S. Southwest – Major Climate-related **Water** Impacts Underway



(Source: *New York Times*, October, 2010)

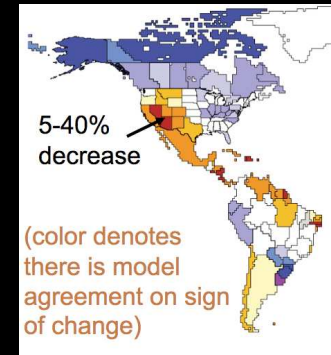
U.S. Southwest – The Climate Challenge

Change Projected by 2100



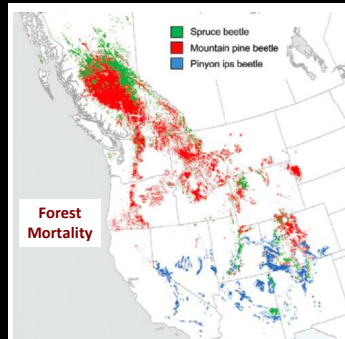
...even **by mid-century**, and with modest reductions in carbon dioxide emissions, the **Colorado River flow will likely decrease**

- Published estimates ALL indicate there will be less water flowing in the Colorado
- Best estimate - **10 to 20% less average flow by 2050**
- Implies that there is a **30% chance that ALL Colorado River Basin storage could go dry by 2050** (Rajagopalan et al., 2009)

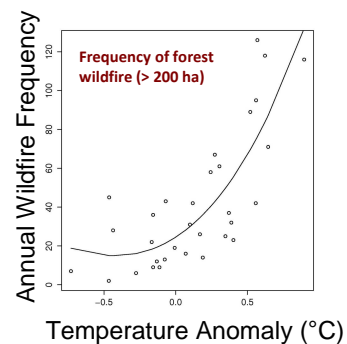


Base figure from Milly et al., 2008

U.S. Southwest – Major Climate-induced Ecosystem Impacts Underway

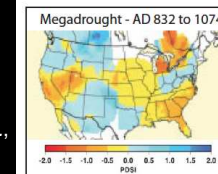
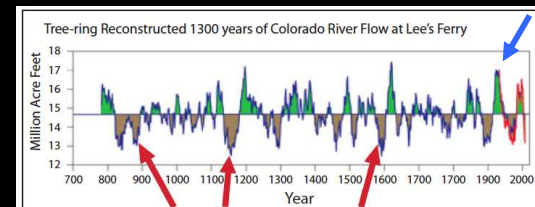


(Source: Raffa et al., 2008; Westerling et al., 2006)



U.S. Southwest – The climate challenge

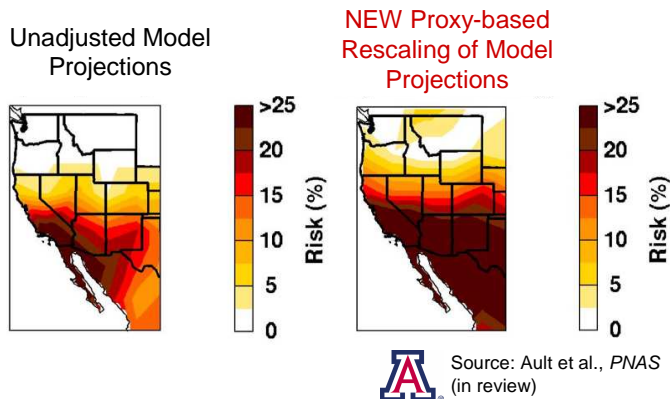
Decades-long "Megadrought" occurs regularly



(Sources: Meko et al., 2007; Karl et al., 2009; Cook et al., 2010; photo by J. Overpeck)

Emerging issue...

Risk of a Multi-decade “megadrought” in the 21st century likely higher than currently thought



Summary Betting Guide for Climate Change in Arizona

More greenhouse gas emissions means...

- Warmer – sure bet (happening already)
- Less snow – excellent odds (happening)
- Drier soils – excellent odds (happening)
- Less late winter snow/rain – good odds (happening)
- Less water in rivers – esp. Colorado River – good odds (already happening)
- More intense rain and more flooding – good odds
- More frequent/severe drought - good odds
- Hotter drought - excellent odds (happening)

The climate challenge is clearly a tough one for the Arizona and the Southwest... ground zero for climate change in the U.S.

But is the news all bad?

The climate challenge also includes opportunities, particularly with respect to:

- adaptation capability (e.g., no-regrets adaption to hot drought)
- efficiency and renewable energy, solving the climate challenge also means cleaner air and a major economic advantage for Arizona
- avoiding conflicts and crisis over water supply



Photo: J. Overpeck

2010 - record global temperatures during near-record solar minimum – another confirmation that changes in the sun are not driving global warming

